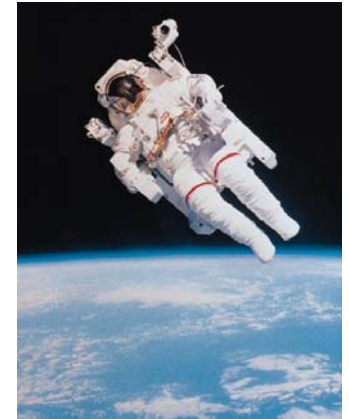# Software Risk Approaches:
An Institutional Perspective

John C. Kelly, Ph.D.

Office of Chief Engineer

Dec. 7th , 2005

What makes Software technology special for NASA?

- **The Up Side:**
  - Software has an extraordinary advantage in space and aeronautics applications to significantly increasing functionality while maintaining or reducing mass
  - The cost of deploying systems is high. It is worth the investment to build autonomy and flexibility into these systems via software
  - Software engineering provides missions with capabilities that would not be practical with any other technology
    - The only replaceable part for most spacecrafts after launch, …

- **The Down Side**
  - Software developed for or by NASA projects has not consistently met expectations and needs
  - The complexity/permutations of software technology exceeds other subsystem elements
  - Future programs and projects will require <u>enormous amounts of NASA specific software</u>
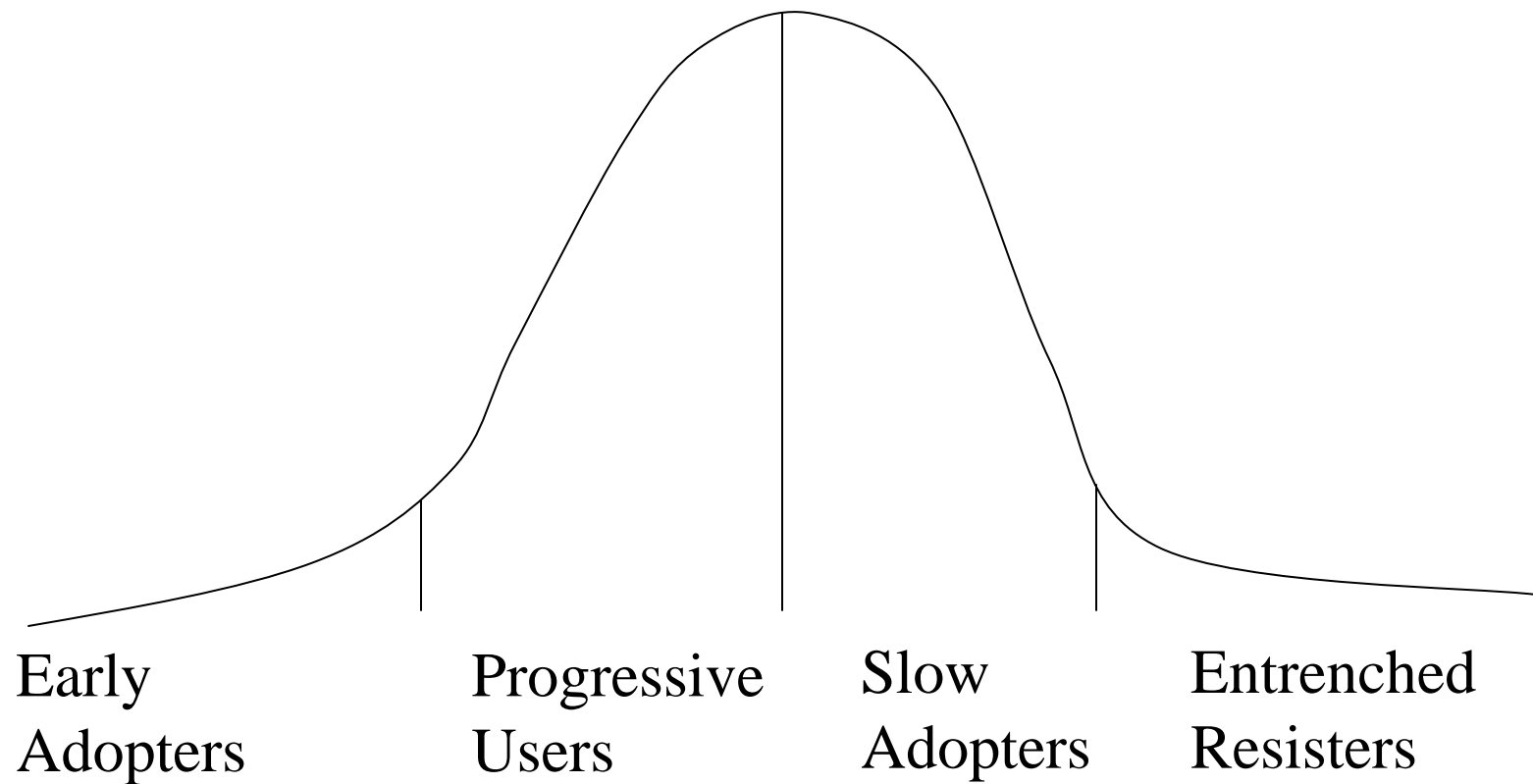
The NASA Software Engineering Initiative

- Started 4 years ago to address the institutional risk NASA faced with software technology

- Goal: Advance software engineering practices (development, assurance, and management) to effectively meet the scientific and technological objectives of NASA

- Premise: Better processes and techniques preformed by more knowledgeable software engineers will lower software risks

Profile of target software engineering audience

Early
Adopters

Progressive
Users

Slow
Adopters

Entrenched
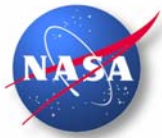Resisters

NASA Software Engineering Initiative: Elements

- **Agency-wide coordination, advocacy, and sharing**
    - NASA Software Working Group
    - NASA Software Assurance Working Group
- **Develop & implement effective policies, procedural requirements, standards, and processes**
- **Develop & implement component plans at each NASA Center**
- **Use of accepted industry benchmarks for software engineering assessments (CMM/CMMI)**
- **Enhance knowledge and skills in software engineering**
- **Development and use of software metrics**
- **Improve NASA's capability in software acquisition**
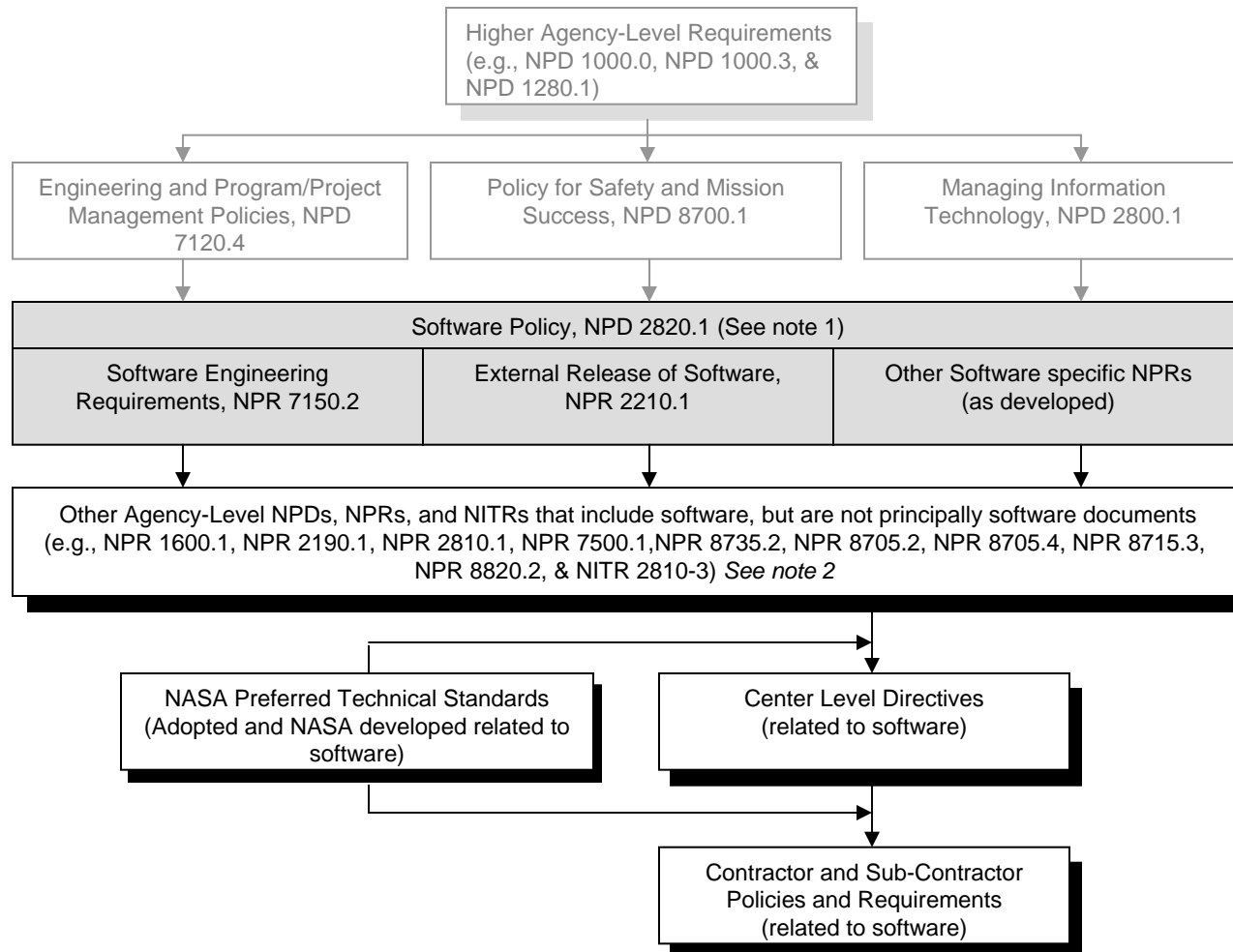- **Infuse software engineering research and technology** 5

Policies, procedural requirements, standards, and processes

I. Policies, Procedural Requirements, & Standards

1. NPD 2820.1C, NASA Software Policy (updated)

2. NPR 7150.2, NASA Software Engineering Requirements (new)

3. NASA-STD-8739.8, NASA Software Assurance (update)

4. NASA-STD-8719.13, Software Safety Standard (update)

II. Processes

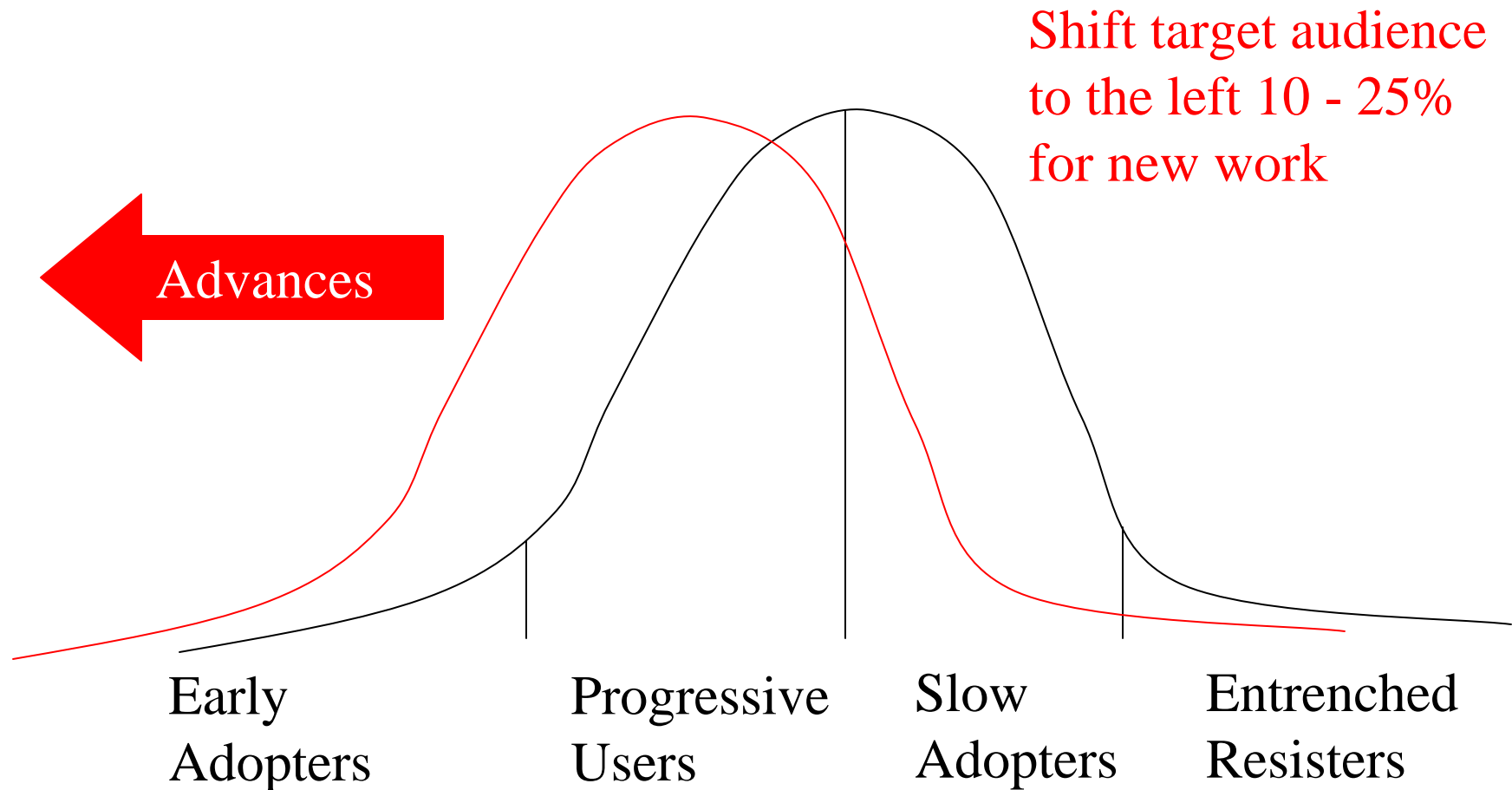1. NASA Process Asset Library (new)

2. Processes at each NASA Center

NASA Software Documentation Tree

Higher Agency-Level Requirements (e.g., NPD 1000.0, NPD 1000.3, & NPD 1280.1)

Engineering and Program/Project Management Policies, NPD 7120.4

Policy for Safety and Mission Success, NPD 8700.1

Managing Information Technology, NPD 2800.1

Software Policy, NPD 2820.1 (See note 1)

Software Engineering Requirements, NPR 7150.2	External Release of Software, NPR 2210.1	Other Software specific NPRs (as developed)

Other Agency-Level NPDs, NPRs, and NITRs that include software, but are not principally software documents (e.g., NPR 1600.1, NPR 2190.1, NPR 2810.1, NPR 7500.1,NPR 8735.2, NPR 8705.2, NPR 8705.4, NPR 8715.3, NPR 8820.2, & NITR 2810-3) *See note 2*

NASA Preferred Technical Standards (Adopted and NASA developed related to software)

Center Level Directives (related to software)

Contractor and Sub-Contractor Policies and Requirements (related to software)

Purpose of policies, procedural requirements, standards, and processes

Shift target audience to the left 10 - 25% for new work

Advances

Early Adopters

Progressive Users
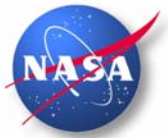
Slow Adopters

Entrenched Resisters

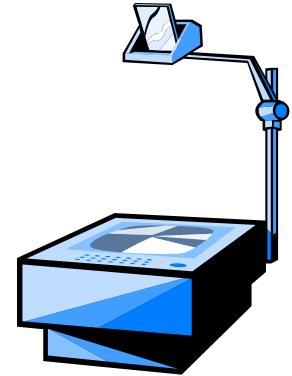# Component plans & assessments at NASA Centers

- Plans signed by Center Director
- Establishment of Software Engineering Process Groups at the Centers
- Development/update of Center level processes
- CMM/CMMI appraisals

|	Number of Pre-Appraisals	Number of Rated Appraisals
Software	25	17
(Systems)	11	-

Knowledge and Skills in Software Engineering

- ## Classes at Centers
  - Training plans at each Center that support local Software Engineering Improvement Plans

- ## Agency-wide ViTS classes and seminars

- ## Software website
  - Software.nasa.gov

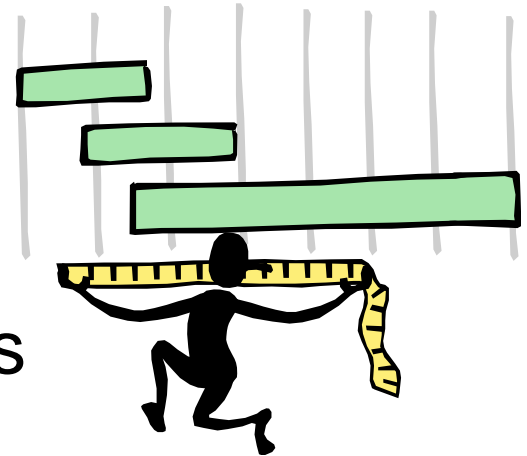- ## Development of a Software Engineering curriculum for entry through top level personnel

Profile of Knowledge and Skills target audience

Early Adopters

Progressive Users

Slow Adopters

Entrenched Resisters
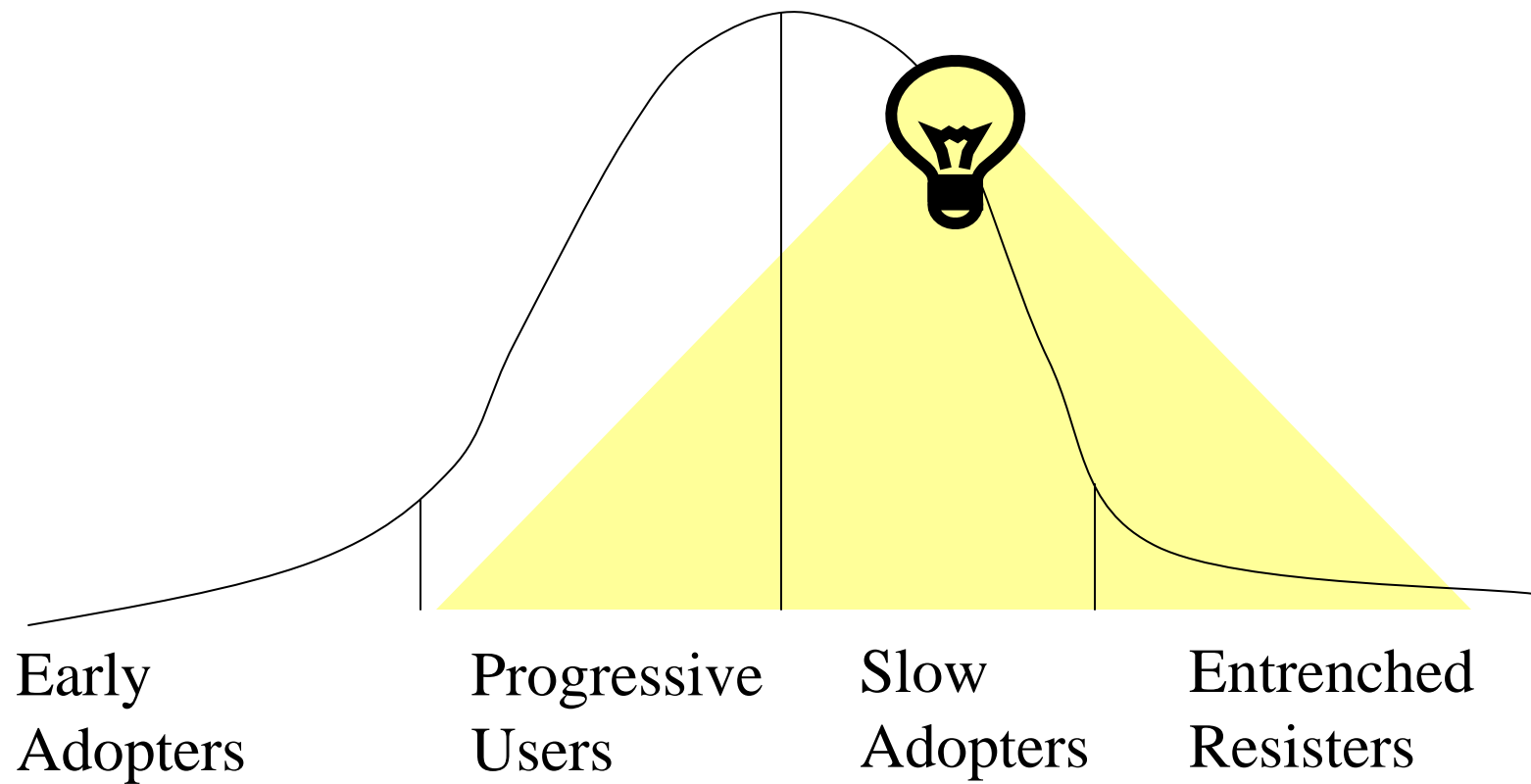
Software Measurement

- Software Measurement Workshops
- Software Measurement Surveys
- Tutorial and hands on support for selecting Project-level software measures
    - Goal, Question, Measure
- Development & approval of procedural requirements for NASA measurement areas for new projects*

* Five Areas: Progress Tracking, Functionality, Quality, Requirements Volatility, & Product Characteristics

Improve NASA's capability in software acquisition

- NASA's top 10 software acquisition problems
- Acquisition Workshop
- Development & approval of procedural requirements for acquisition
- Recommended the development of CMMI – Acquisition
- Participation in Software Engineering's Institute's development of CMMI – Acquisition

# Infuse software engineering research and technology

- Select software research candidate technologies that are ready to be transitioned into NASA projects
- Find good matches between candidate technologies and specific project needs
- Fund* small infusion efforts to ease the use of new technologies
- Publication of a new journal
    - "Innovations in Systems and Software Engineering: A NASA Journal"

* Note: Funding is collaboratively provided by the Software Assurance Research Program which is sponsored by the Office of Safety and Mission Assurance and managed by the NASA IV&V Facility

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Profile of Research Infusion target audience

Early
Adopters

Progressive
Users

Slow
Adopters

Entrenched
Resisters
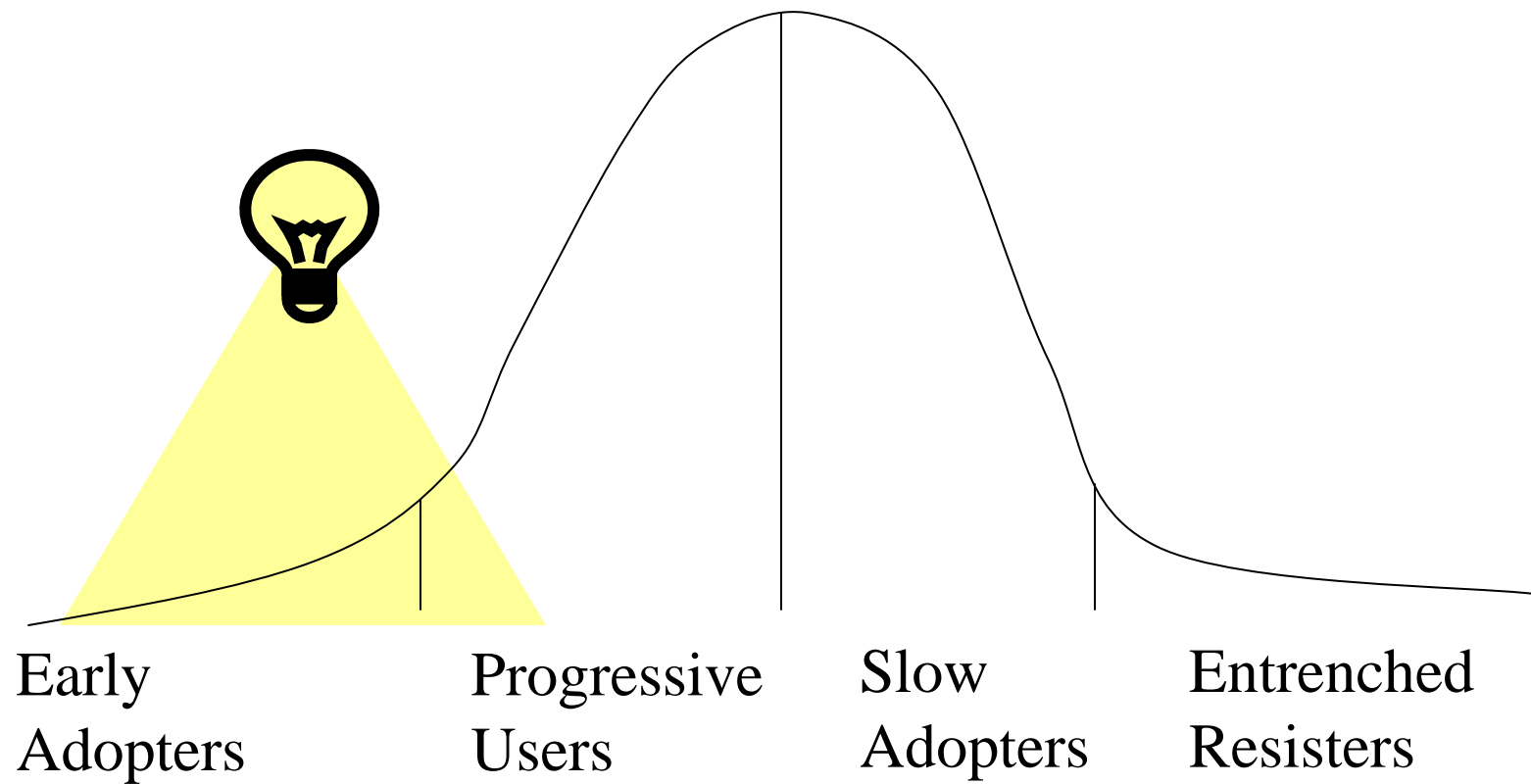
Specific Risk Management Activities

- **Develop & implement effective policies, procedural requirements, standards, and processes**
  - Requirement to identify, analyze, plan, track, control, communicate, and document software risks consistent with NPR 7120.5 and NPR 8000.4 (NPR 7150.2, SWE-086)
  - Process Asset Library* (a number of specific Risk Management processes)
- **Develop & implement component plans at each NASA Center**
  - Inclusion of all Center organizations responsible for the performance of mission-critical software development, management, and acquisition.
- **Use of accepted industry benchmarks for software engineering assessments (CMM/CMMI)**
  - Assessments at Centers against the Risk Management process area in CMMI
- **Enhance knowledge and skills in software engineering**
  - Integrated Risk Management training in software courses (CMMI, metrics, inspections, acquisition, …)
- **Development and use of software metrics**
  - Software Inventory (used to prioritize projects containing software based on criticality)
- **Improve NASA's capability in software acquisition**
  - Top ten acquisition problems
  - Update of acquisition training materials
- **Infuse software engineering research and technology**
  - Infusion of risk reduction research and technology into projects
  - Software Cost Reduction tool (from NRL), SpecTRM (Safeware), CodeSurfer (Gamma Tech.), Perspective Based Inspections (Fraunhoffer Inst.), …

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Summary

- NASA is stronger in software development, assurance, and management than it was four years ago

- A supportive institutional environment needs to be effectively used to reduce specific software risks
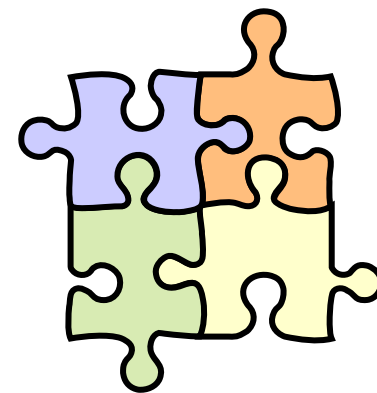
Acknowledgements

- **Agency-wide coordination, advocacy, and sharing**
  - NASA Software Working Group – Tim Crumbley, MSFC, Co-lead
  - NASA Software Assurance Working Group – Martha Wetherholt, HQ OSMA, lead, Burt Sigal, JPL, Co-lead
  - Software Steering Board – Chris Scolese, Chair
- **Develop & implement effective policies, procedural requirements, standards, and processes –** NPR & Standards development teams, reviewers, Center SEPGs
- **Develop & implement component plans at each NASA Center –** Center Software Working Group leads & SEPGs
- **Use of accepted industry benchmarks for software engineering assessments (CMM/CMMI) –** Center Software Working Group leads & SEPGs
- **Enhance knowledge and skills in software engineering –** Darrell Thomas, KSC, Tony Maturo HQ OCE, Kathryn Greenly, & Wiley Larson
- **Development and use of software metrics –** Sally Godfrey, GSFC and Myrna Regardi (Fraunhoffer Institute)
- **Improve NASA's capability in software acquisition –** Chuck Niles, LaRC and Pat Schuler, LaRC
- **Infuse software engineering research and technology –** Tom Pressburger, NASA Ames, Ken McGill, IV&V Facility, & Martha Wetherholt, HQ OSMA

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  - **Jet Propulsion Laboratory:** Burt Sigal & Chi Lin
  - **Johnson:** Jeff Phillips & Chuck Noyes
  - **Kennedy:** Jim Kania & Darrell Thomas
  - **Langley:** Pat Schuler & Chuck Niles
  - **Marshall:** Tim Crumbley & Cathy White
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